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WATER ANALYSIS AND THE NITROGEN CONTENT OF WATER

By William M. Booth

All available scientific data, both chemical and bacteriological, should be collected and studied before judgment is passed on a water supply used for food, and such should be systematically recorded by all water works companies.

The nitrogen content of water and the chemical conditions in which this is found have long been considered very valuable, nor is there at present any good reason to discredit the use of such reports.

All sanitarians are familiar with the gradual change of animal and plant nitrogen in the combined form until it reaches the inorganic nitric state, and the chemical changes will not be further discussed than to remark that unpolluted natural waters, with few exceptions, are remarkably free from nitrogen. The analyses[1] are recorded to show how the waters of central New York differ in nitrogen content and in what state this element has been found. All tests have been made according to the methods prescribed by Wanklyn and Mason and are tabulated in parts per million. The total solids determination is the weighed residue from 50 cc. of water, evaporated to dryness on the water bath and placed in a desiccator over sulphuric acid for twelve hours. Chlorine has been determined volumetrically, according to Mason, unless above 50 parts per million, when the gravimetric method was employed. Free and albuminoid ammonia are determined separately, and a check has been made in each instance by estimating the total ammonia in another sample. If this form of nitrogen is known to be unusually high, as in the case of sewage, 10 or 100 cc. are diluted with ammonia free water and are distilled as an original sample, using a proper dilution factor. The nitrates and nitrites are determined according to the Mason method and were made in duplicate using freshly prepared standard solutions. The "oxygen consumed" test is made according to the Mason method. All results shown are the work of the writer unless credited to others. The bacteriological analyses were made by the bacteriologist of the city of Syracuse.

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[1] This paper is a supplement to a paper in the September, 1914, *Journal*, The Use of Nitrate Test in Determining Source of Pollution of a Water Supply, and is intended to correct errors in printing the 1914 paper. The following typographical errors are also noted in the paper in the September *Journal:*

On page 602, first line of second paragraph, read Fig. 2.

Page 602, last line for No. 2 read No. 53.

Page 604, sixth line of first paragraph for No. 4 read No. 55.

Page 606, table heading eighth column read Oxygen consumed and ninth column read Colonies per cc.

Page 609, Nos. 124–126 for New Syracuse read Near Syracuse.

Turning now to the analytical tables (p. 606, vol. 1, no. 3, September, 1914, *Journal*) analyses 1 to 7 inclusive show that rain, snow, ice and distilled water may contain free ammonia, albuminoid ammonia, nitrates and nitrites.

Analyses 22 to 26 inclusive show the absence of nitrites in Syracuse city water beginning at the upper or south end of Skaneateles lake, about 32 miles from the city, and at various points in its progress to the city, with a final analysis in a downtown city block. The water shed has an area of about 74 square miles and nitrites are seldom found in this water. Such sometimes occur in November and during the latter part of March. During the past ten years, the writer has never detected more than 0.002 parts per million. The overflow from the lake becomes the source of power for several mills and contains the sewage from the villages along the stream. The nitrogen in this water is shown in analyses 27 to 30 inclusive. Paper, felts, and woolen cloth are manufactured.

Onondaga creek is a country stream that enters the city of Syracuse at the south end. It is, at present, an open sewer and enters Onondaga lake with a fall through the city of about 40 feet. Analysis 8 was made from a sample taken from the creek as it enters the city, and number 9 shows the nitrogen condition of the water as it enters the lake.

Numbers 9 to 17 inclusive were made at about equal distances through the length of Onondaga Lake, which is five miles long. This lake is the sewage outlet for the city of Syracuse, the town of Solvay and the village of Liverpool. The waters of the lake are naturally very salt. A high nitrite content throughout shows a very unstable condition from a nitrogen standpoint. The Seneca River analysis No. 20 was made at the junction and the large decrease in salt roughly indicates the degree of dilution, as the river water is not unusually high in chlorine.

Number 21 is the analysis of a sewer water from the city that enters the lake.

At its mouth Onondaga Creek has a nauseating odor and contains suspended solids. At the Seneca River junction, the samples taken were free from odor and contained practically no suspended solids.

Numbers 38 to 40 inclusive are tests of Lake Ontario water, and were made to show the efficiency of the mechanical filtration plant of the Rochester and Lake Ontario Water Company at Charlotte.

Number 42 is the analysis of Hemlock Lake water which is the main supply of the city of Rochester. It is now used in conjunction with the purified water from Lake Ontario. Both sources of supply are considered excellent and the total nitrogen content is low.

Number 41 is an analysis of unfiltered Niagara River water, used in the city of Lockport.

Numbers 80 to 83 show that the supply of the city of Fulton is a composite water. The Great Bear Spring has no connection with the well known water of that name. Just west of Fulton there is a lake, the water of which is used for manufacturing purposes in the city. The outlet is low and sluggish, and analysis 31 shows the condition of the water at this point. After use in manufacturing, the increase in nitrogen is shown in numbers 32 to 37 inclusive. The latter is undiluted factory waste.

The village of Seneca Falls (see map in September, 1914 *Journal*) is supplied by water from Cayuga Lake just above the northern outlet. At this point the lake is shallow; many cottages are located on the western bank, and the village of Cayuga lies opposite. Although 40 miles in length and, at points, several hundred feet in depth, a number of large towns sewer directly into this lake, and nitrites are normally present in samples taken from the outlet, especially after the summer season. To determine the condition of the water at the north end of the lake, analyses 43 to 51 were made. The writer testified that the nitrites found in this water showed pollution too serious to admit of its use in the raw state, while several well known experts declared that the water was entirely potable. However, a mechanical filtration plant has been installed by order of the state Board of Health.

Numbers 92 to 95 inclusive are analyses of new wells, driven in low ground beside the Clyde River. Employees drank this water for a short time, but were physically inconvenienced and another source was substituted.

Numbers 96 to 100 inclusive are analyses made after seven deaths from typhoid fever, supposed to have been caused by impure water, at a club house in the Adirondacks. The location, on the banks of a river, was formerly ideal, but the waters of the stream were dammed by the state at a point several miles below, and the banks overflowed for miles. The water was made stagnant and trees were killed on both banks. Presumably the sewage contaminated the wells which were driven in sand. A new source was secured on higher ground, a septic tank was built, and no severe sickness from water has occurred since.

The remaining analyses have been taken from miscellaneous records, and are explained in the margin. Numbers 101 and 102 are particularly interesting, as the highest nitrate nitrogen recorded in the list was found at this point. After the barn had been turned into a garage, the well became available as a potable water supply.

Numbers 103, 104, and 105 show how a new well furnishes water of varying quality. This well was pumped continuously from September to December, by means of an air lift.

Number 106 is extraordinarily high in nitrites.

The above analyses show the nitrogen content of some central New York waters, and from them the writer draws the following conclusions:

Many natural waters of this area contain nitrogen in all of the forms reported in the analytical scheme.

Water containing sewage is in a highly unstable condition as regards the form in which nitrogen is found.

Records should be kept showing the nitrogen content of potable waters, and weekly, if possible daily, tests should be made.

No quantitative relationship exists between the nitrogen of water and the bacteriological content.

The presence of nitrites in water ordinarily free from this form of nitrogen must be regarded with suspicion.

If nitrates are present in water above one part per million, it may have an unhealthy source.